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A STANDARDIZED PROCEDURE FOR RESIDUE SAMPLING

A Committee Report

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Soil and Water Conservation Research Division
Agricultural Research Service
United States Department of Agriculture

in cooperation with

Great Plains Agricultural Experiment Stations

A STANDARDIZED PROCEDURE FOR RESIDUE SAMPLING[1]

A Committee Report[2]

This standardized procedure for residue sampling has been devised for interpretation and use of experimental data from various locations to develop principles and practices of stubble-mulch maintenance for soil and water conservation.

A study of research experience with stubble-mulch farming in the Western States showed that no uniform procedures were employed by research workers for collecting, processing, and reporting residues. Too, only limited measurements were made of the effects of varying amounts of surface residue on factors influencing the soil environment and plant growth and development.

The literature reveals little information on the quantitative effects of stubble mulch on physical and chemical properties of the soil, on moisture conservation, on soil temperatures, on plant growth and development, or on amounts needed for soil protection from water erosion. Neither Zingg and Whitfield (8)[3] nor McCalla and Army (7) in their reviews of stubble-mulch farming research cited much data where amounts of residue had been measured frequently enough in field studies to determine their influence on the soil environment.

Duley (5) prepared for use of action agency personnel, a handbook on estimating the amount of crop residue on a field. Such information is used to determine how well the land is protected against soil and water losses and also serves as an aid in checking the efficiency of tillage methods used in a stubble-mulch system of farming. Krall, Power, and Massee (6) developed the yardstick method as an aid in determining the amount of residues present on fallowed land. The procedure was primarily for use of action agencies. After making a few measurements by this method it is usually possible to estimate visually the amount of residues present with enough accuracy to determine the type of fallowing equipment that should be used to provide sufficient residues for erosion control at the end of the fallow period.

McCalla and Army (7) stated that "no standardized procedure has been developed to measure accurately the amount of residue under field conditions. Lack of standardization in measuring techniques has, without doubt, resulted in a considerable amount of confusion and misinterpretation of stubble mulch data."

There are some investigations of interest in this area, however. Barnes and Bohmont (2) applied different quantities of straw to seven different soils and used artificial rainfall

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[1] Contribution from Soil and Water Conservation Research Division, Agricultural Research Service, U.S. Department of Agriculture.

[2] The Committee consisted of the following personnel of the Agricultural Research Service, Soil and Water Conservation Research Division: C. J. Whitfield, Chairman, J. J. Bond, E. Burnett, W. S. Chepil, B. W. Greb, T. M. McCalla, J. S. Robins, F. H. Siddoway, R. M. Smith, and N. P. Woodruff.

[3] Numbers in parentheses refer to Literature Cited at the end of this publication.

in an effort to evaluate cover effects on the water intake rate. Their results showed that quantity of residues as well as soil characteristics have an important influence on water intake. Furthermore, it was evident from this study that the amount of residues present becomes more and more important on the less permeable, fine-textured soils.

Krall, Power, and Massee (6) also measured residues in conducting research on the amounts of residue required to control erosion. The results showed that amounts depended on erodibility of different soils. On some soils all available residue was required, but on others as much as 70 percent of the residue could be destroyed during fallow. This information, used after properly measuring available residue, is valuable in choosing implements and tillage sequences.

Investigators at the Wind Erosion Laboratory, Manhattan, Kans., have emphasized the importance of knowing the quantity of residue on the soil surface. They have shown the amount of residues needed to protect different kinds of soil against wind erosion (3), the relative erosion control effectiveness of wheat and sorghum stubble,[4] and residue reduction by various types of tillage.[5] In all of these studies, residue sampling under field conditions was essential.

In Canada, Anderson (1) used a procedure of residue measurement designed to reduce variability. He obtained significant differences in his research on surface trash conservation with tillage machines.

All of these studies emphasize the desirability and need for making residue measurements. Data are needed on the influence of varying amounts of residues on the soil environment from harvest through the cropping sequence to the period when the growth of the succeeding crop plays a major role. Soil characteristics determine the need for residues and the amount of residues required for improvement of soil environment and plant development, and for soil protection. On the other hand, the amounts of stubble available determine procedures to follow to maintain needed quantities of residues for effective soil management.

The standardized procedure for residue sampling to be presented here is the product of the thinking of a number of scientists and engineers throughout the United States. A uniform method for collecting, processing, and reporting residues by research workers was developed by a committee of ARS personnel in 1960. This report was circulated to scientists and engineers in the 17 Western States. After consideration of the suggestions received, Special Report No. 99 was prepared and sent for review to workers in this subject matter field in all sections of the country. A number of good suggestions were received and incorporated into the procedure reported here.

COLLECTION OF RESIDUES

Size of Sampling Area

The sampling area should be a minimum of 1 square yard for small grains and grasses.

[4] Siddoway, F. H. 1960. Effect of quantity, kind, and orientation of wheat stubble on relative soil erodibility. Mimeograph.

[5] Woodruff, N. P., Fenster, C. R., Chepil, W. S., and others. 1961. Residue maintenance with various types of tillage machinery. Mimeograph.

A minimum of 2 square yards is recommended for sorghum and corn. This area may need to be larger in some locations if plant population is low.

The size and shape of the sampling area, the size of the plot, and the overall number of samples to be taken must be carefully considered. Otherwise, many difficulties may be encountered. If plots are too small, a high percentage of residues may be removed. The material could be returned to the plot after weighing, but plot disturbance and anchoring the residue would make this a questionable practice. Samples may be obtained from areas adjacent to the experimental plot without jeopardizing the plot for water and wind erosion investigations. Samples could well be taken from the experimental plot itself, where the research is concerned with physical and chemical properties of the soil, incidence of disease and insects, or similar problems, or where the plots are field scale.

Orientation and Shape of Sampling Area

A fixed frame is valuable for sampling where crop rows are indistinct. Where crop rows are distinct, a yardstick or an adjustable frame can be used. The adjustable frame is oriented across several rows, center to center between rows, with two sides parallel to row direction.

The principal method used for coarse residues such as sorghum stubble and stalks is one whereby the row spacing is measured and the required length of row to make a 2-square-yard sample is computed. This eliminates the need for a frame, since a linear measurement of row width will suffice.

Figure 1.--Sampling wheat residue prior to initial tillage. (Courtesy of C. R. Fenster, Nebraska Agricultural Extension Service.)

The shape and location of the sampling area need careful consideration to insure an adequate representative sample. This is due to a number of factors including the wide variety of row spacings encountered in sampling, standing wheat and sorghum stubble, tilled or disturbed stubble where the rows are not distinguishable, and areas where a combine spreads straw or tillage equipment windrows or bunches it.

Number of Samples

A minimum of eight random samples of the field or treatment is required, unless a fewer number will yield data adequate for the purpose. The samples should be processed separately.

The number of samples required per treatment depends on the purpose of the measurement and on the variability between samples from the same treatment. Residue reduction

studies with various types of tillage have shown that 3 samples per plot and 3 replications per treatment--giving a total of 9 samples per treatment--may be required for statistically significant differences between implements. However, this number of samples was not sufficient to evaluate the effects of a single operation with 32-inch sweeps on the amount of residue before tillage as compared to the amount left after tillage. Here, variability was extremely high. Computations to determine the number of samples required to obtain significant differences showed that 14 to 15 samples per plot might be required. On the other hand, measurements made to determine the effect of surface residue on wind erodibility have shown that as few as 3 samples per plot or treatment are ample. In considering these and other results, apparently 3 samples are sufficient for certain types of measurements but up to 15 may be required for other types of measurements (5).

Method of Taking Samples

Collect only aboveground or visible parts of all vegetation or vegetative residue. This is done by clipping partially buried and undisturbed vegetative material at the soil surface.

Figure 2.--Prewinter sampling of residue after wheat drilling. (Courtesy of W.W. Harris, Kansas Agricultural Experiment Station.)

Materials such as weed growth, volunteer growth, and animal manures may be measured and reported separately, according to the objectives of the study.

The hand method, with shears, is the best way to gather residues. A flexible-fingered leaf rake to gather the loose residue from a measured area prior to clipping with shears and handpicking may hasten sampling.

Aboveground parts include stems, leaves, and stalks, but exclude grain. It is recognized that crowns become exposed by subsequent tillage operations, and that other solid material such as manure may also be present. Materials of this type may be important in their effects on soil environment and water erosion control, and in such cases these materials should be collected and weighed separately. For water erosion studies, measurement of residue should also include that incorporated in the surface 2 inches of soil.

Supplementary Information

Take supplementary data such as residue length, height, percent standing, anchored and ground cover, orientation and uniformity of distribution; stalk diameter for corn and sorghum; width of rows; plant population; and any other significant data deemed desirable.

Such supplemental information is useful in explaining some variations within and between treatments. Doubtful data may become conclusive data when these and other observations such as insect infestations, droughts, excessive moisture, and weeds have been noted.

PROCESSING RESIDUES

Washing

Place residue on 2-mm. screen, which is about the size of ordinary window screen, and wash thoroughly with pressure hose to remove all soil. It may be necessary to break sorghum and cornstalks to be sure the sand and soil are removed from the leaf sheaths. Also, using too much pressure on the water before the material becomes too wet is undesirable. Very dry wheat straw, in particular, may be subject to considerable breakage and loss if too much pressure is used at the beginning of washing.

It takes two to three times longer to thoroughly hand clean a dry sample than to wash it. Normal washing time is 2 to 4 minutes, and normal drying time 24 to 48 hours (sorghum).

Up to 50 percent of the total weight of a handpicked sample may be soil. Thus, percent variation can be great. Such large and variable proportions of soil, if not removed, can lead to completely erroneous residue estimates. A range of 10- to 30-percent difference has been found between weights of washed ovendried and hand-cleaned, dry samples. Washing removes the invisible soil and some water-soluble plant material, leaving a more consistent and reliable weight of residues.

Residue crowns cannot be satisfactorily cleaned if they are dry. Weights of dry-cleaned and washed crowns can differ by as much as 40 percent.

A procedure used to wash sorghum residue at Big Spring, Tex., contains an additional step, but takes equal or even less time. In brief, a box with a screen bottom has been used to wash the residue samples. A sample to be washed is placed in the box and then the box is placed in a pan containing water. The residue, which floats, is scrubbed and agitated vigorously with the hands. If stalks need to be broken or leaves removed, it can be done at this time. After this step is completed the box with the sample is removed from the pan of water and washed with the high-pressure hose.

When this procedure is used the entire sample is in contact with the water and not just that portion on which the high-pressure hose is directed. This facilitates the loosening and removal of soil.

Drying and Weighing

Ovendry at 70°C. to constant weight; weigh to two significant figures. To facilitate drying, sorghum and corn residues may be chopped. Preliminary results at North Platte, Neb., indicate drying time can be greatly reduced by this procedure.

It is recognized that substantial differences may not exist between the recommended ovendried and thoroughly air-dried residue samples. However, due to difficulties in air-drying such as lack of time, insufficient space to store samples, and damage by rodents or mold, ovendrying is more efficient and gives more reliable results.

REPORTING OF DATA

Report as pounds of washed, ovendry residue per acre. When total residues are over 1,000 pounds per acre, report to nearest 100; when under 1,000 pounds per acre report to nearest 10.

CONCLUSION

The committee hopes that scientists and engineers conducting research on residue management problems can be encouraged to measure and report the amounts of residues with which they are working. The use of a standardized procedure will make it possible to interpret and use experimental data from various locations for developing principles and practices of stubble-mulch maintenance for soil and water conservation.

LITERATURE CITED

1. Anderson, D. T. 1961. Surface trash conservation with tillage machines. Canad. Jour. Soil Sci. 41: 99-144.

2. Barnes, O. K., and Bohmont, D. W. 1958. Effects of dryland cultural practices on water intake rates. Wyo. Agr. Expt. Sta. Ann. Prog. Rpt. (1957-58).

3. Chepil, W. S., and Woodruff, N. P. 1955. How to reduce dust storms. Kans. Agr. Expt. Sta. Cir. 318, 11 pp.

4. _____1959. Estimations of wind erodibility on farm fields. U.S. Dept. Agr. Prod. Res. Rpt. 25, 21 pp.

5. Duley, F. L. 1958. Estimating the amount of crop residue on a field. U.S. Dept. Agr., Agr. Handb. No. 136, 31 pp.

6. Krall, J. L., Power, J. F., and Massee, T. W. 1958. Summer fallowing methods related to erosion and wheat production. Mont. Agr. Expt. Sta. Bul. 540, 34 pp.

7. McCalla, T. M., and Army, T. J. 1961. Stubble mulch farming. Advances in Agronomy 13: 125-196. New York.

8. Zingg, A. W., and Whitfield, C. J. 1957. A summary of research experience with stubble mulch farming in the Western States. U.S. Dept. Agr. Tech. Bul. 1166, 56 pp.

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